



Aeronet Global Communications Inc.,
Corporation Trust Center, 209 Orange Street,
Wilmington, New Castle, Delaware 19801
Registered in Delaware – 5440011
if@aeronetglobal.aero

Commission's Secretary,
Office of the Secretary,
Federal Communications Commission Headquarters
445 12th St., SW,
Room TW-A325,
Washington, DC 20554

September 28, 2016

Regarding: GN Docket No. 14-177 FNPRM on Mobile use in bands above 24GHz

Dear Sirs,

We welcome your Further Notice of Proposed Rulemaking (FCC 16-89) regarding the 71-76GHz and 81-86GHz frequency bands (referred to as E band hereafter) and wish to submit further comment in relation to GN Docket No. 14-177. Our comments are in addition to those submitted in Feb' 2016 as part of the previous Notice of Proposed Rulemaking (FCC 15-138) for GN Docket No. 14-177.

We have submitted this letter part in confidence due to the commercially sensitive nature of some details. Aeronet derives independent economic value from the confidential information and the fact that such confidential information is not known to the public, including Aeronet's competitors. Such economic value would be degraded – and Aeronet would be unfairly disadvantaged – were the confidential information to be made available to the public, including Aeronet's competitors.

As we highlighted in our previous submission to the first NPRM, the general interest in this band has increased significantly in the past and continues more recently. Interest in relation to uses involving aerial platforms continues from Facebook, (Google) X and Aeronet. New aviation related interest has been expressed by Airborne Wireless Network in the USA and long range E band terrestrial links interest expressed by China Mobile. It is Aeronet's belief

that these activities have demonstrated a clear service demand based on a dynamic air to ground and air to air point to point link use in E band.

In the case of Aeronet's activities, work on demonstrating 1Gbps connectivity to aerial platforms is currently ongoing in Ireland. This is supported by ComReg, the Irish Spectrum Regulator and the IAA, the Irish Aviation Regulator.

Aeronet has also progressed its medium term plans to host a demonstration of this 1Gbps connectivity to a larger aerial platform in the USA. An appropriate N registered test aircraft has been secured for this purpose. This event is planned to be hosted in conjunction with our In-Flight Entertainment and Connectivity Service Operator partner(s).

In the following pages we provide our commentary in relation to the FNRPM specific to 71-76GHz and 81-86GHz and as listed under heading V of REPORT AND ORDER AND FURTHER NOTICE OF PROPOSED RULEMAKING, adopted July 14, 2016.

In summary, we feel the FCC should proceed to a Report and Order for mobile operations (including aeronautical) in E band largely in line with the proposed rules, subject to some suggested amendments. The resulting Report and Order will provide the necessary supportive regulatory environment to allow the continued development of very high bandwidth services for aviation consumers.

Your sincerely,

A handwritten signature in blue ink, appearing to read "Ivor Fitzpatrick", written over a horizontal line.

Ivor Fitzpatrick
Director
For an on behalf of
Aeronet Global Communications INC
Corporation Trust Center,
1209 Orange Street,
Wilmington,
New Castle,
Delaware 19801

Aeronet Commentary on §369-516

General Discussion

Aeronet welcomes and supports the principles of the CRBS and SAS outlined for the 3.5GHz band. The addition of a time based characteristic to the efficient sharing of spectrum should be welcomed. It is important to note the 3.5GHz band is far smaller and more congested than the E band. As noted by the FCC (§ 432) only 16 counties have a transmitter / receiver density greater than 1 per square mile and the remaining 3,125 counties and county-equivalents could be considered as the functional equivalent of a green field. Also the beamwidths typically associated with E band further helps contribute to the efficient sharing of the spectrum between multiple operators. As such the operational methodology of any SAS system adopted and the technical rules applicable to uses should reflect this context.

Aeronet notes the FCC discussion (§ 432) regarding the adequacy of spectrum for new uses/services in addition to incumbent operations and the low average density of registered sites. In addition, Aeronet draws attention to the relatively small range of elevation that these links operate within. As such, uses/services that take advantage of minimum uptilt / downtilt angular separation (i.e. separation on a vertical axis) or operate above these ranges of elevation should be considered greenfield.

Aeronet notes the FCC discussion (§ 433/434) regarding the electromagnetic characteristics of E-band and the potential for a variety of uses, including more flexible fixed uses. It is Aeronet's belief that some mobile uses, limited by beamwidth, should be part of these variety of uses. Various parties have already completed technology development in E band that relates to both long link ranges and mobile use cases. Such examples include –

- Public media reports from DARPA's Mobile Hotspot Phase 1 in 2014¹ which achieved ranges >50kms with directional antenna <8" mounted on an aerial UAV platform.
- (Google) X continued testing, under FCC license, in New Mexico

Aeronet is also currently conducting a scope of works in Ireland testing the performance of E band data links from a fixed ground location to the moving aerial platform at a variety of range distances. The early interim milestone of this testing is on course to replicate the 1Gbps performance at >40kms to manned aircraft, using readily available components in a field test environment. The later milestones shall demonstrate longer range performance in a laboratory test environment.

¹ <http://www.unmannedsystemstechnology.com/2014/04/darpas-mobile-hotspots-program-looks-to-integrate-wireless-networks-on-uavs/>

Based on Aeronet's already completed architecture design work and the expected validating results from these tests, Aeronet firmly believes a >1Gbps connectivity service for the commercial aviation / aerospace industry can be created from a fixed / mobile point to point link use type in E-band. This represents a major step change in service levels of airline passenger when compared to current connectivity networks. Further details are shown in section Appendix A1.

Studies² have shown even over oceanic flight routes, these link ranges combined with aircraft density are sufficient to enable a stable mesh network between moving aerial stations and fixed location ground stations.

Aeronet notes the FCC discussion (§435-439) on the coexistence of multiple services / uses in the band. Aeronet does not seek comment on the appropriate beamwidth for other uses including a relaxation for point to point fixed service links. The service proposed by Aeronet can operate within the current maximum 0.6 degree beamwidth rule.

Aeronet agrees the extension of existing uses and the introduction of new uses is an important part of the continued development of services within E band. Aeronet agrees a central coordinating database, like a Spectrum Access System (SAS), could help facilitate this once the correct balance is struck between protecting tiered uses and assuming control over key day-to-day operational parameters within an operator's network management functions.

Subject to appropriate access controls the SAS could also coordinate with Federal Fixed-Satellite Service operations located at the 28 military bases and the 18 Federal radio astronomy observatories, albeit via a dedicated module like an ECS. This capability should at a minimum enforce current exclusion zones and the results of 'yellow light' license reviews. In time the capability should be evolved to a less restrictive sensor based approach based on empirical readings.

Therefore, in principle Aeronet agrees a SAS based regulatory framework once adapted to the characteristics of E band would provide a suitable and flexible framework.

Rules as part of UMFUS / CBRS

Aeronet is generally in favour of including these E band rules in Part 96 (CBRS) subject to the commentary below.

² "North Atlantic Inflight Internet Connectivity via Airborne Mesh Networking" by D Medina, F Hoffmann, F Rossetto, C Rokitanisky. Institute of Communications and Navigation, German Aerospace Center (DLR)

Given the likelihood of no PAL in a large number of census tract license areas, the incumbent and GAA users shall largely be reliant on the technical rules and SAS for protection from interference. Albeit on a shared basis for GAA users. This does provide a higher amount of certainty than would otherwise be available from unlicensed part 15 rules.

The existing licensing scheme for E band provides unpaired channels of 1.25GHz, which may be aggregated at single transmitter/receiver sites. Aeronet suggests a review of actual channel size in use by current links registered in the third party databases would provide valuable insight. It is Aeronet's belief, a significant number of links operate with only one 1.25GHz channel per direction.

Most current commercially available E band fixed link radio devices operate with channels size in multiples of 250MHz. Throughout the recent discussions regarding the potential uses for spectrum >24GHz, most commentary has suggested 500MHz of spectrum is required to provide sufficient high speed services to consumers.

Aeronet suggest adopting a 500MHz channel size and retaining the ability to aggregate channels, strikes the right balance of accommodating existing uses and maximising spectral separation flexibility for expanded uses. This would make 20 channels available across the entire band for the SAS and would be consistent with channel sizes adopted in other international jurisdictions.

Aeronet notes in Part 96 where there is only a single applicant seeking PALs in a geographic area, and therefore no mutual exclusivity, the FCC highlights the best way to discharge their statutory mandate to "encourage the larger and more effective use of radio in the public interest" is to provide access to such spectrum via shared GAA use. The PAL auction shall be cancelled and all applicants shall be assigned to the GAA tier.

If only one applicant for PALs is received for the license area but the applicant can demonstrate that certainty of frequency assignment is essential to maintaining its service across multiple license areas, then Aeronet suggest PALs should be assigned. Failing to do so opens the risk that GAA user demand shall exceed available supply thus damaging the applicant's service. Such a PAL assignment could be subject to -

- A PAL aggregation cap of 10 number 500MHz channels in order to ensure sufficient available spectrum for GAA users
- Demonstrated actual usage in line with the applicant's service explanation. To avoid spectrum warehousing
- Via a process similar to the current long form application to ensure no objectors

Should the FCC decide not to adopt this suggestion, then Aeronet believes a similar method of channel quantum certainty for the resulting GAA user is essential.

Access Tiers

Aeronet support the establishment of the three tiers (1) Incumbent Access users, (2) Priority Access Licensees (PALs), (3) General Authorized Access (GAA) users and the protections afforded to higher tier users.

Aeronet suggest the existing system for protecting Federal incumbents remains appropriate during the transition timeframe above. Following this period, the FCC should seek to upgrade the SAS to utilise a sensor based automated system via an ECS.

Given the envisaged extension of uses for point to point fixed service links, the sensory data input required for the ECS / SAS protection method and the potential relaxation of beamwidth for non-Federal incumbent users, Aeronet believes it is appropriate to require the transition of non-federal incumbents to the new service rules proposed in a reasonable timeframe.

Based on the number of nationwide licenses compared to the number of registered fixed links and likely percentage of bi-directional communications, a two year timeframe would appear appropriate to plan and execute such a transition. Also adopting a similar 'light license' scheme for GAA users affords non-federal incumbents a simplified method to transition to the new rules. During this transition period they should be grandfathered incumbent access.

Aeronet regards the choices for authorisation methods of PALs and GAA users as linked together. In particular, the proposed census tract area size for PALs should be combined with the non-exclusive nationwide licenses of the existing E band structure for GAA users.

Aeronet has proposed an international data connectivity service operating at high altitudes. This is further described in section A2. This service uses a combination of point to point links between a mix of fixed and mobile transmitter / receiver devices. The fixed transmitter / receiver devices can operate as PALs from a reasonable number of ground based locations nationwide using uptilted antenna angles. The mobile transmitter / receiver devices can operate as GAA sites from a multitude of high altitude dynamic locations nationwide.

Given the scale of the investment required to provide nationwide service from this combination of point to point links across two access tiers, Aeronet believes a level of license certainty beyond 1 year is appropriate. Instead of longer license terms, an operator who meets a set of operational criteria during the current term could be assured a similar

license for the following term. Subject to: a) all other financial, standing, eligibility, foreign ownership, etc criteria being satisfied; and b) lack of mutually exclusive PALs applicants. Below are suggested operational criteria that could apply -

- Require a minimum number of fixed location ground station PAL licenses to justify the ability to support a nationwide GAA tier of mobile aerial stations at altitude
- Hold a nationwide GAA tier class A and C license (*see below for class C license*)
- Operate a minimum number of point to point links between mobile aerial stations

Aeronet believes authorisation of GAA users should not be delayed till after the initial PAL term. Such a delay would directly impact the creation of the data connectivity service, thus depriving airborne end consumers access to a true broadband customer experience.

Technical Rules

Aeronet supports the authorization of dynamic beamforming antennas that conform to the same requirements that apply to conventional antennas used for point-to-point links

Aeronet suggest a further sub-division of the class A license within the technical rules for rural and non-rural locations. This is similar to the rules adopted for the 3.5GHz band. Making it attractive to locate fixed ground based PAL sites in rural locations, away from other users, further reducing the risk of interference to other users. The definition of rural to be in line with that in Part 96 CBRS rules.

Aeronet suggests the additional for a class C license for mobile transmitter / receiver devices, performing point to point link operations. This license would be authorized only to operate within a range of altitudes; include airborne operations; authorized to use comparatively high power levels; and would be required to use tight beamwidth antenna.

The restriction of equipment from this class C license to a range of altitudes can help ensure no interference with equipment from other license classes. Where an operator seeks to communicate with equipment in another license class, the operator would require the appropriate access tier and license class for that fixed transmitter / receiver or base station.

Suggested technical rules for Class A and C licenses are shown below -

	Class A1 Rural	Class A2 non rural	Class C
Antenna height	Min 10ft AGL	Min 30ft AGL	3,000ft-60,000ft
Antenna tilt	n/a	n/a	n/a
Max P1 out / channel	37dBm	35dBm	37dBm
Max. beamwidth	0.6°	0.6°	0.6°
Max. EIRP / channel	87dBm	85dBm	87dBm

Auto Transmit PC	Required	Required	Required
Modulation	digital	digital	Digital
Installer qualification	Professional	Professional	Professional
Geo location / Orientation	n/a	n/a	Self aware

Both the fixed and mobile transmitter / receiver devices proposed by Aeronet shall always be located more than 20cm from people. Their mode of operation is based on a point to point link.

As described above, Aeronet proposes mobile transmitter / receiver devices operating at high altitude. These transmitter / receiver devices shall be installed at specific locations on aerial platforms which by their nature are mobile. Therefore, Aeronet suggests the technical rules for this equipment can be set with reference to –

- similar fixed transmitter / receiver devices
- the aerial platform's mobility performance
- their class C license

Acknowledging the requirement for efficient use of spectrum, Aeronet agrees user equipment should only be allowed to transmit only when it is locked onto a serving base station, with the possible exception of brief pilot or sounding signals.

Aeronet agrees the SAS should maintain and verify information for base stations and fixed transmitter / receiver devices. In addition, Aeronet agrees fixed transmitter / receiver devices should maintain similar information on any mobile transmitter / receiver device it is operating a point to point link with. This information should be made available to the SAS if requested by the SAS. Further information on how Aeronet proposes to meet these requirements is shown in section A3.

As a principle the minimum geographic positional accuracy for point to point links should always be such that the transmitter signal, operating at maximum allowed beamwidth for the class of license, is assured to include the receiver. The accuracies for the E band services of ± 50 meters horizontal and ± 3 meters of elevation are achievable for class A and B license devices given their installation locations. For class C devices, the accuracy is limited by the aerial platform. Given the current ADS-B deployment regulations worldwide (see 14 CFR § 91.227 for USA), Aeronet suggest any aerial platform housing a class C license device should be required to have ADS-B Out functionality as a minimum.

As suggested above, exploiting spectral separation opportunities from a 500MHz channel size opens the ability for the SAS to delegate positional awareness of and non-interference from mobile transmitter / receiver devices. This can be done while the SAS maintains a supervisory control mechanism. By assigning a quantum of channels to a specific operator,

the SAS can delegate the transmit power and azimuth directions for mobile transmitter / receiver devices to the specific operator. The SAS can rely of the spectral separation as a control mechanism to assure no interference to other uses in the license area. For class C license devices, the SAS can further rely on the spatial separation as an additional protection to class A and B users.

This opportunity is mainly applicable to license areas with low density of use. Given the number of census tracts and likely types of services / uses, this could be a substantial geographic area. This is more fully described in relation to the Aeronet service in section A3.

Protection Method

Initially Aeronet supports a method based on an aggregated received signal level at various height levels within PAL areas. For both Priority Access and GAA users, other transmitter devices must be managed such that the aggregate received signal strength, measured at any location on the Service Area boundary of any co-channel PAL, shall not exceed an average power level of -80 dBm in any direction when integrated over the reference channel bandwidth. The measurement antenna placed at a height similar to the Priority Access and GAA users equipment. Unless the affected PAL licensees agree to an alternative limit and communicate that to the SAS

Heavily register counties

Combining the spectral separation opportunities of a 500MHz channel size with the geographic separation from the use of census tracts, Aeronet believes the proposed regulatory framework is well placed to address even the 16 counties heavily registered with incumbent users.

SAS

Aeronet supports the SAS operations outlined in the FNPRM in conjunction with the commentary of this submission. In particular in facilitating a stable spectrum environment the SAS should engage directly with GAA users to identify mechanisms to simplify the assignment of frequencies and permissible transmission power levels, for example as described above.

- Determine the available frequencies at a given geographic location and assign them to PAL and/or GAA licensees;
- Determine the maximum permissible transmission power level for incumbent, PAL, and GAA licensees at a given location and communicate that information;
- Register and authenticate the identification information and location of incumbent, PAL and GAA licensees;

- Enforce Exclusion and Protection Zones, including any future changes to such Zones, to ensure compatibility between non-Federal users of spectrum in the 71-76 GHz and 81-86 GHz bands and incumbent Federal operations;
- Ensure that PAL and GAA licensees protect non-Federal incumbent users consistent with the rules;
- Protect Priority Access Licensees from impermissible interference from other users;
- Facilitate coordination between GAA users to promote a stable spectral environment;
- Ensure secure and reliable transmission of information between the SAS, ESC, and PAL and GAA licensees;
- Provide any ESC that the FCC might approve with any sensing information reported by PAL and GAA licensees if available;
- Facilitate coordination and information exchange with other SASs and exchange information, as needed, with NTIA.

Alternative methods

As suggested above, Aeronet believes the ability to award exclusive use under a PAL, even when demand doesn't exceed supply, is an important enabler to bring innovative services into the market. This allows an operator with a nationwide service to have certainty over the minimum channel blocks necessary to establish a reliable service.

To fully implement this suggestion an additional nationwide Priority Access tier would be required for high altitude only use covered by a class C license.

In order to achieve this suggestion Part 96.29(d) would need to be amended. All other proposals could remain as suggested in the FNPRM and as per the commentary in this submission.

Appendix

This section contains confidential information from Aeronet's engineering designs and business plans.

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